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(54) **WIRELESS COMMUNICATION DEVICE AND TRANSMISSION POWER CONTROL METHOD**

(57) Desired signal power measured at a desired signal power measuring circuit 105 is averaged over a plurality of slots by an averaging circuit 106 to reduce a power error in desired signal power of each slot. An SIR measuring circuit 108 calculates SIR(n) of each slot from the average value of desired signal power in the plurality

of slots and the measured value of interference signal power of each slot, and a TPC generating circuit 109 makes a comparison between SIR(n) of each slot and a threshold value, and generates transmission power control information. This makes it possible to control transmission power for each slot with high accuracy in asymmetrical communication.

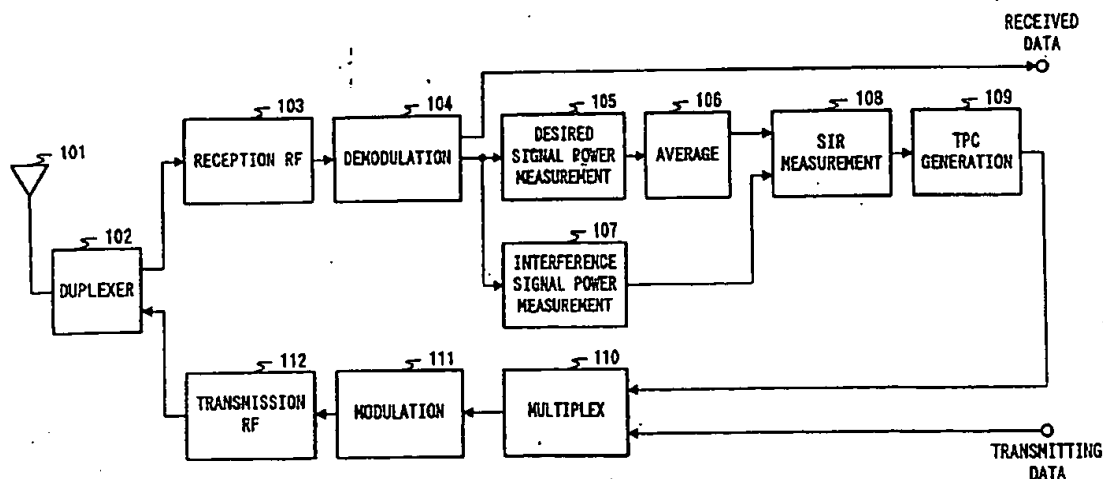


FIG. 1

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## Description

### Technical Field

[0001] The present invention relates to a radio communication apparatus and a transmission power control method, which are used in a radio transmitting system such as a mobile phone, a cellular phone and the like.

### Background Art

[0002] In a radio transmitting system such as a mobile phone, a cellular phone and the like, an SIR (Signal to Interference Ratio) is fixed and transmission power control is carried out in accordance with the state of each transmission channel in order to maintain a BER (Bit Error Rate) at a value below a predetermined value.

[0003] The transmission power control method includes a closed loop transmission power control and an open loop transmission power control.

[0004] The closed loop transmission power control is a method for controlling transmission power based on the contents of a TPC (Transmit Power Control) command where SIR corresponding to reception quality of a transmitting signal from one end is measured at the other end of communication and the TPC command, which reduces transmission power when a measured SIR value is higher than a target SIR value and which increases transmission power when the measured SIR value is lower than the target SIR value, is transmitted through an inverse channel.

[0005] On the other hand, the open loop transmission power control is a method for controlling a transmission power value in such a way that a reception level is subtracted from the known transmission level of the other end of communication to calculate a level lost in a radio section and a target reception level of the other end of communication is added to the lost level.

[0006] Here, data communication in which the information amount of a forward link is greatly larger than that of a reverse link is expected to be mainstream in the future, and the development of a radio communication system of asymmetrical communication where the information amount of the reverse link is asymmetrical with respect to that of the forward link is proceeding.

[0007] In the case of the radio communication system where the information amount of the reverse link is symmetrical with respect to that of the forward link, since a time difference between transmission timing and reception timing is small, transmission power can be controlled for each slot with high accuracy.

[0008] However, in the radio communication system that performs asymmetrical communication where a time difference between transmission timing and reception timing becomes large, a method for controlling transmission power for each slot with high accuracy has not been disclosed yet.

## Disclosure of Invention

[0009] It is an object of the present invention to provide a radio communication apparatus and a transmission power control method capable of controlling transmission power for each slot with high accuracy in asymmetrical communication.

[0010] The above object can be attained by averaging desired signal power over a plurality of slots to reduce a power error in desired signal power in the respective slots and to improve precision of measurement.

## Brief Description of Drawings

[0011]

FIG. 1 is a block diagram illustrating the configuration of a radio communication apparatus according to a first embodiment of the present invention;

FIG. 2 is a block diagram illustrating the configuration of a radio communication apparatus as a communication partner with respect to the radio communication apparatus of the first embodiment of the present invention;

FIG. 3 is a block diagram illustrating the configuration of a radio communication apparatus according to a second embodiment of the present invention; and

FIG. 4 is a block diagram illustrating the configuration of a radio communication apparatus as a communication partner with respect to the radio communication apparatus of the second embodiment of the present invention.

## Best Mode for Carrying Out the Invention

[0012] Embodiments of the present invention will be specifically explained with reference to the drawings accompanying herewith.

(First embodiment)

[0013] The first embodiment explains the case of the closed loop transmission power control. FIG. 1 is a block diagram illustrating the configuration of a radio communication apparatus according to the first embodiment of the present invention.

[0014] A duplexer 102 switches a channel through which a signal passes at a transmitting time and a receiving time and outputs a signal received from an antenna 101 to a reception RF circuit 103, and outputs a transmitting signal outputted from a transmission RF circuit 112 to the antenna 101.

[0015] The reception RF circuit 103 amplifies the received signal, frequency-converts the amplified signal to a baseband, and outputs the resultant to a demodulating circuit 104. The demodulating circuit 104 demodulates the baseband signal to extract received data of

the radio communication apparatus.

[0016] A desired signal power measuring circuit 105 measures reception power (hereinafter referred to as "desired signal power") of a known signal included in the output signal of the demodulating circuit 104, and outputs a measuring result to an averaging circuit 106. The averaging circuit 106 calculates an average value of desired signal power in a plurality of slots, and outputs the average value to an SIR measuring circuit 108.

[0017] Here, in the case where a known signal sequence is long and an interference signal can be suppressed and the slots are close to each other and variations in reception power due to fading is small, desired signal power in the respective slots is substantially equal to each other. Accordingly, the calculation of the average value of desired signal power in the respective slots makes it possible to improve accuracy of measurement in desired signal power.

[0018] An interference signal power measuring circuit 107 measures power of an interference signal outputted from the demodulating circuit 104, and outputs a measuring result to the SIR measuring circuit 108.

[0019] The SIR measuring circuit 108 calculates SIR(n) (n indicates slot number) of each slot from the average value of desired signal power in the plurality of slots and the measured value of interference signal power of each slot, and outputs the resultant to a TPC generating circuit 109.

[0020] The TPC generating circuit 109 makes a comparison between SIR(n) of each slot and a threshold value, and generates transmission power control information, which instructs the slot whose SIR(n) is lower than the threshold value to increase transmission power, and generates transmission power control information, which instructs the slot whose SIR(n) is higher than the threshold value to reduce transmission power. After that, the TPC generating circuit 109 outputs generated transmission power control information of each slot to a multiplexing circuit 110.

[0021] The multiplexing circuit 110 multiplexes a plurality of pieces of transmission power control information into one slot transmitting data and outputs the resultant to a modulating circuit 111. The modulating circuit 111 modulates an output signal of the multiplexing circuit 110, and outputs the modulated signal to a transmission RF circuit 112. The transmission RF circuit 112 converts the frequency of an output signal of the modulating circuit 111, amplifies transmission power, and transmits the amplified transmission power as a radio signal from the antenna 102 through a duplexer 102.

[0022] FIG. 2 is a block diagram illustrating the configuration of a radio communication apparatus as a communication partner with respect to the radio communication apparatus of FIG. 1.

[0023] A duplexer 202 switches a channel through which a signal passes at a transmitting time and a receiving time and outputs a signal received from an antenna 201 to a reception RF circuit 203, and outputs a

transmitting signal outputted from a transmission RF circuit 208 to the antenna 201.

[0024] The reception RF circuit 203 amplifies the received signal, frequency-converts the amplified signal to a baseband, and outputs the resultant to a demodulating circuit 204. The demodulating circuit 204 demodulates the baseband signal and outputs the demodulated signal to an isolating circuit 205. The isolating circuit 205 isolates an output signal of the demodulating circuit 204 into received data and transmission power control information.

[0025] A CL (Closed Loop) transmission power control circuit 206 controls an increase or decrease in transmission power at the transmitting RF circuit 112 based on transmission power control information isolated at the isolating circuit 205.

[0026] A modulating circuit 207 modulates transmitting data and outputs it to the transmitting RF circuit 208. The transmitting RF circuit 208 converts the frequency of the output signal of the modulating circuit 207 and amplifies transmission power based on control of the CL transmission power control circuit 206, and transmits it as a radio signal from the antenna 201 through the duplexer 202.

[0027] Thus, desired signal power is averaged over the plurality of slots and the closed loop transmission power control is performed using the average value, making it possible to reduce a power error in desired signal power in the respective slots and to improve precision of measurement. This also makes it possible to control transmission power for each slot with high accuracy in the closed loop transmission power control of asymmetrical communication.

(Second embodiment)

[0028] The second embodiment will explain the case of the open loop transmission power control having an outer loop that controls reference power for transmission power control. FIG. 3 is a block diagram illustrating the configuration of a radio communication apparatus according to the second embodiment of the present invention. In the radio communication apparatus illustrated in FIG. 3, the same reference numerals as those of FIG. 1 are added to the configuration portions having the same operations as those of the radio communication apparatus illustrated in FIG. 1, and the explanation is omitted.

[0029] The radio transmission apparatus illustrated in FIG. 3 adopts the configuration in which an error correcting/decoding circuit 301, a CRC deciding circuit 302, and a transmission power deciding circuit 303 are added to the radio communication apparatus illustrated in FIG. 1.

[0030] The error correcting/decoding circuit 301 provides error correcting/decoding processing to an output signal of the demodulating circuit 104, and extracts received data. The CRC deciding circuit 302 performs a

CRC decision to the output signal of the demodulating circuit 104. The transmission power deciding circuit 303 calculates a transmission reference power value  $SiRt$  of a communication partner using a CRC decision value outputted from the transmission power deciding circuit 303 as a reference of reception quality.

[0031] Here, generally, in the case of performing transmission using a plurality of transmission slots, in order to scatter the positions of the error bits to improve an error correction capability, interleave is performed in such a way that transmitting signals of all slots are arranged at random. In this case, the radio communication apparatus transmits a signal indicative of transmission reference power value  $SiRt$  to the communication partner to make it possible to control transmission power of the communication partner such that the reception quality subjected to error correction processing in all slots satisfies a predetermined quality.

[0032] The radio communication apparatus, however, cannot exercise control to the communication partner in response to interference amount of each slot using only transmission reference power value  $SiRt$ . This cannot reduce transmission power with respect to the slot whose interference amount is small, with the result that interference with other cells cannot be reduced.

[0033] In order to solve the above problem, the transmission power deciding circuit 303 of the radio communication apparatus adds  $SIR(n)$  of each slot to the calculated transmission reference power value  $SiRt$  to calculate a transmission reference power value  $SiRt(n)$  of each slot.

[0034] The multiplexing circuit 110 multiplexes information indicative of transmission reference power value  $SiRt(n)$  to transmitting data, and outputs the resultant to the modulating circuit 111.

[0035] FIG. 4 is a block diagram illustrating the configuration of a radio communication apparatus as a communication partner with respect to the radio communication apparatus of FIG. 3. In the radio communication apparatus illustrated in FIG. 4, the same reference numerals as those of FIG. 2 are added to the configuration portions having the same operations as those of the radio communication apparatus illustrated in FIG. 2, and the explanation is omitted.

[0036] The radio transmission apparatus illustrated in FIG. 4 adopts the configuration in which a desired signal power measuring circuit 401 for the CL transmission power control circuit 206 and an OL (Open Loop) transmission power control circuit 402 are added as compared with the radio communication apparatus illustrated in FIG. 2.

[0037] The isolating circuit 205 isolates the output signal of the demodulating circuit 204 into received data and a transmission reference power control value  $SiRt(n)$ .

[0038] The desired signal power measuring circuit 401 measures desired signal power  $S$  of the known signal included in the output signal of the demodulating circuit

circuit 204, and outputs the measuring result to the OL transmission power control circuit 402. The OL transmission power control circuit 402 calculates transmission power  $T(n)$  of each slot by equation (1) shown below and controls an increase or decrease in transmission power at the transmitting RF circuit 208. It is noted that  $Const$  in equation (1) is a fixed value for gain control.

$$T(n) = SiRt(n) \cdot S + Const \quad (1)$$

[0039] Thus, the open loop transmission power control is performed with consideration given to  $SIR$  of each slot in addition to the transmission reference power value, making it possible to control transmission power for each slot with high accuracy in asymmetrical communication.

[0040] As explained above, according to the radio communication apparatus and the transmission power control method of the present invention, since the power error in desired signal power of each slot is reduced to make it possible to improve accuracy in measurement, transmission power can be controlled for each slot with high accuracy in asymmetrical communication.

[0041] This application is based on the Japanese Patent Application No. HEI 11-286317 filed on October 7, 1999, entire content of which is expressly incorporated by reference herein.

#### Industrial Applicability

[0042] The present invention is suitable for use in a base station apparatus of a radio transmission system or a communication terminal apparatus.

#### Claims

1. A radio communication apparatus that performs asymmetrical communication, said radio communication apparatus comprising:

desired signal power measuring means for measuring desired signal reception power of a plurality of slots for each slot;  
interference signal power measuring means for measuring interference signal reception power;  
power control information generating means for generating transmission power control information of each slot from said desired signal reception power and said interference signal reception power; and  
transmitting means for transmitting said transmission power control information of each slot through one slot.

2. The radio communication apparatus according to claim 1, further comprising averaging means for cal-

culating an average value of desired signal reception power over the plurality of slots, wherein said power control information generating means generates transmission power control information of each slot from the average value of said desired signal reception power and said interference signal reception power.

3. A radio communication apparatus that performs asymmetrical communication with the radio communication apparatus described in claim 1, said radio communication apparatus comprising:

isolating means for isolating transmission power control information of each slot from a received signal;  
transmission power controlling means for controlling transmission power of each transmission slot based on said transmission power control information of each slot; and  
amplifying means for amplifying transmitting data based on control of said transmission power controlling means.

4. A radio communication apparatus that performs asymmetrical communication, said radio communication apparatus comprising:

first reception quality measuring means for measuring reception quality of the entirety of a plurality of slots;  
second reception quality measuring means for measuring reception quality of each slot;  
reference power calculating means for calculating transmission reference power of each slot based on said reception quality of the entirety of the plurality of slots and said reception quality of each slot; and  
transmitting means for transmitting information of said transmission reference power of each slot through one slot.

5. The radio communication apparatus according to claim 4 wherein said reference power calculating means adds said reception quality of the entirety of the plurality of slots and said reception quality of each slot to calculate transmission reference power of each slot.
6. The radio communication apparatus according to claim 4, wherein said first reception quality measuring means measures said reception quality of the entirety of the plurality of slots based on a CRC checking result.
7. The radio communication apparatus according to claim 4, further comprising desired signal power measuring means for measuring desired signal re-

ception power of the plurality of slots for each slot; and interference signal power measuring means for measuring interference signal reception power, wherein said second reception quality measuring means measures reception quality of each slot based on desired signal reception power to interference signal reception power.

8. The radio communication apparatus according to claim 7, further comprising averaging means for calculating an average value of desired signal reception power over the plurality of slots, wherein said second reception quality measuring means measures reception quality of each slot based on the average value of said desired signal reception power and reception power of said interference signal.

9. A radio communication apparatus that performs asymmetrical communication with the radio communication apparatus described in claim 4, said radio communication apparatus comprising:

isolating means for isolating information of transmission reference power of each slot from a received signal;  
transmission power controlling means for controlling transmission power of each transmission slot based on said information of transmission reference power of each slot; and  
amplifying means for amplifying transmitting data based on control of said transmission power controlling means.

10. A base station apparatus mounting a radio communication apparatus thereon, said radio communication apparatus that performs asymmetrical communication comprising:

desired signal power measuring means for measuring desired signal reception power of a plurality of slots for each slot;  
interference signal power measuring means for measuring interference signal reception power;  
power control information generating means for generating transmission power control information of each slot from said desired signal reception power and said interference signal reception power; and  
transmitting means for transmitting transmission power control information of each slot through one slot.

11. A communication terminal apparatus mounting a radio communication apparatus thereon, said radio communication apparatus that performs asymmetrical communication comprising:

desired signal power measuring means for

measuring desired signal reception power of a plurality of slots for each slot;  
 interference signal power measuring means for measuring interference signal reception power;  
 power control information generating means for generating transmission power control information of each slot from said desired signal reception power and said interference signal reception power; and  
 transmitting means for transmitting transmission power control information of each slot through one slot.

reference power of each slot through one slot, at other radio communication apparatus, said method comprising the steps of:

isolating information of transmission reference power of each slot from a received signal; and  
 amplifying transmission power of each transmission slot based on said information of transmission reference power of each slot.

12. A transmission power controlling method, at one radio communication apparatus that performs asymmetrical communication, said method comprising the steps of:

measuring desired signal reception power of a plurality of slots for each slot;  
 measuring interference signal reception power;  
 generating transmission power control information of each slot from said desired signal reception power and said interference signal reception power; and  
 transmitting transmission power control information of each slot through one slot,  
 at other radio communication apparatus, said method comprising the steps of:

isolating transmission power control information of each slot from a received signal;  
 and  
 amplifying transmission power of each transmission slot based on said transmission power control information of each slot data.

13. The transmission power controlling method according to claim 12, wherein an average value of desired signal reception power is calculated over the plurality of slots, and transmission power control information of each slot is generated from the average value of said desired signal reception power and said interference signal reception power.

14. A transmission power controlling method, at one radio communication apparatus that performs asymmetrical communication, said method comprising:

measuring reception quality of the entirety of a plurality of slots;  
 measuring reception quality of each slot;  
 calculating transmission reference power of each slot based on said reception quality of the entirety of the plurality of slots and said reception quality of each slot; and  
 transmitting information of said transmission

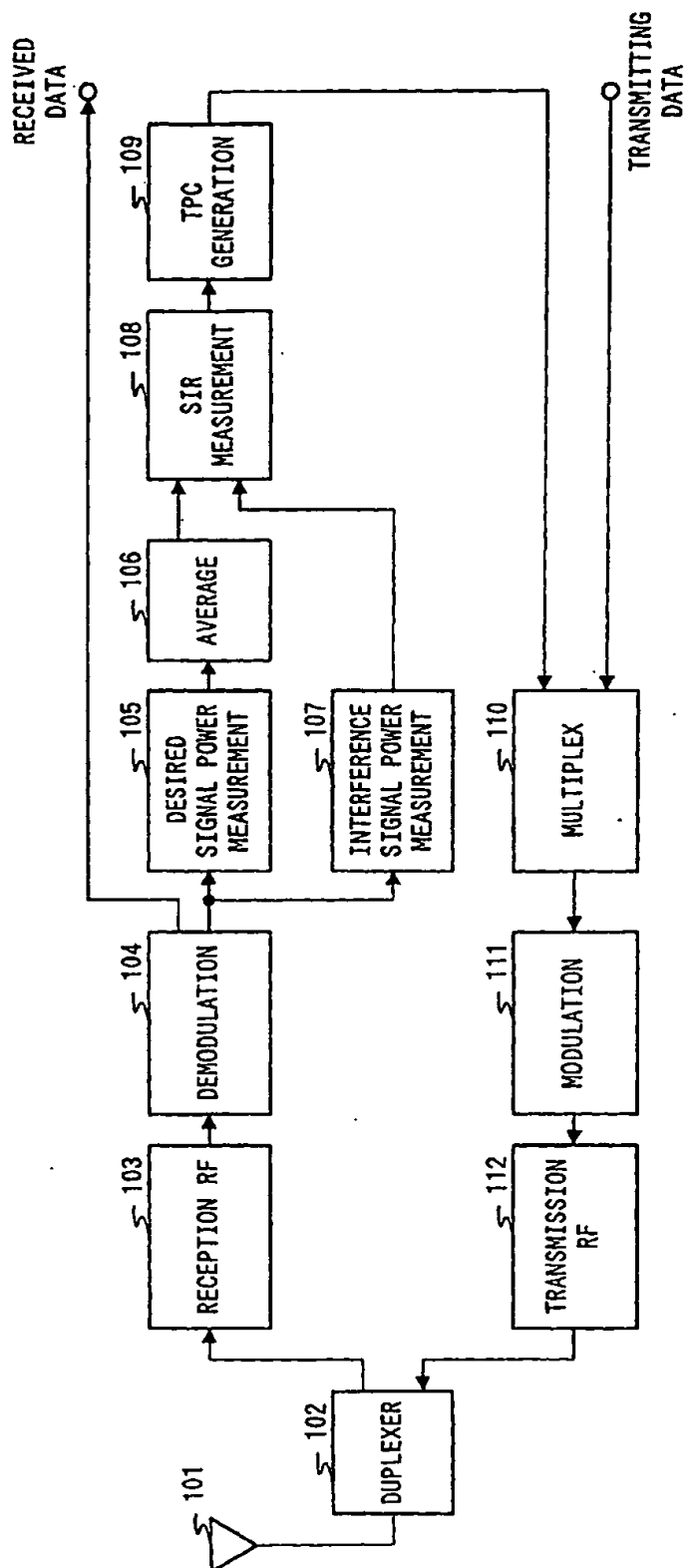


FIG. 1

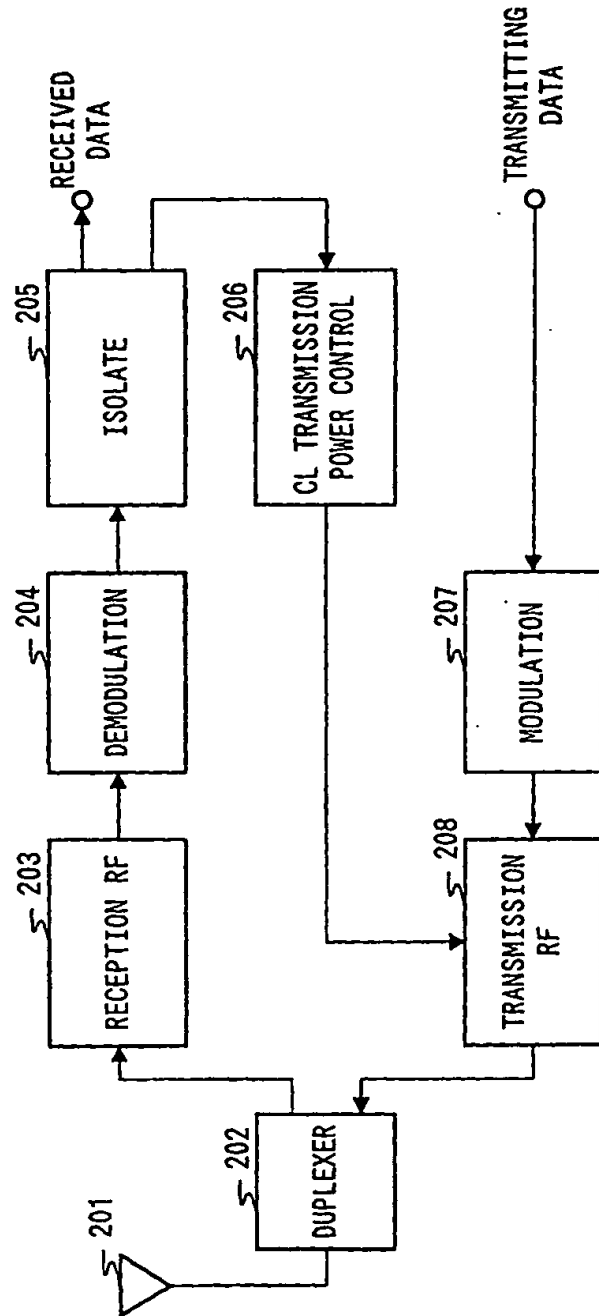


FIG. 2



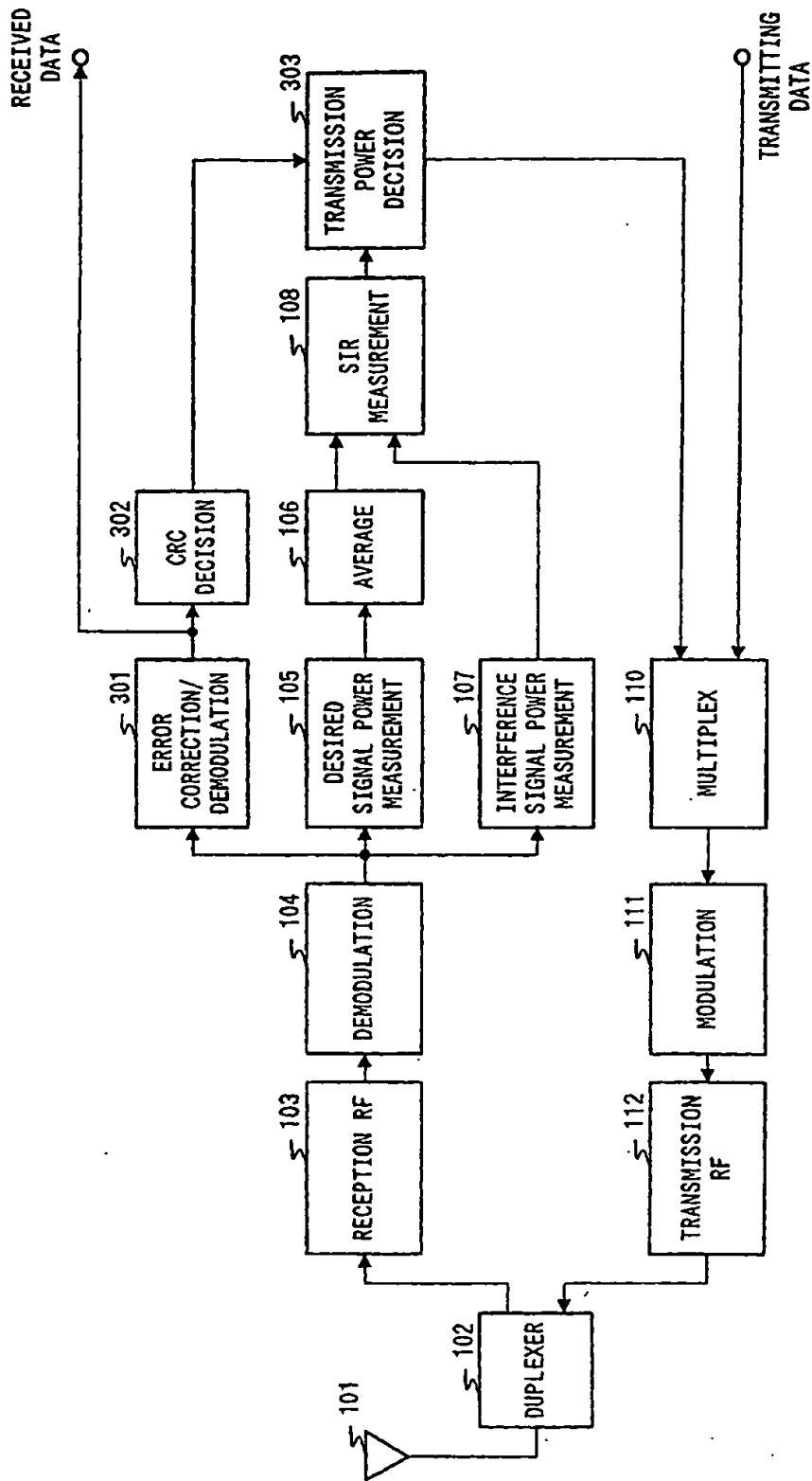


FIG. 3

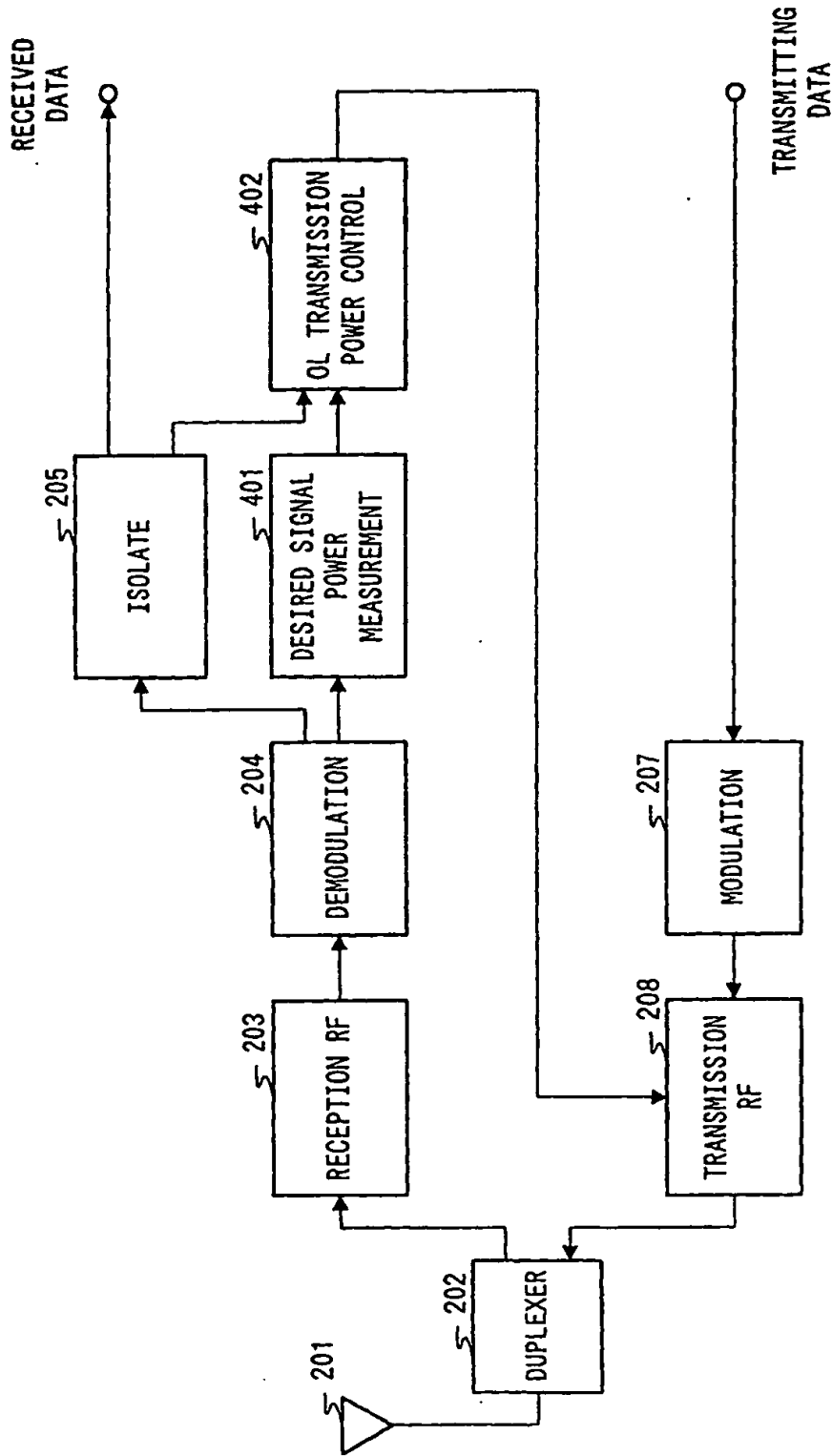


FIG. 4

## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/06973

<b>A. CLASSIFICATION OF SUBJECT MATTER</b>		
Int.Cl. <sup>7</sup> H04Q 7/38		
According to International Patent Classification (IPC) or to both national classification and IPC		
<b>B. FIELDS SEARCHED</b>		
Minimum documentation searched (classification system followed by classification symbols)		
Int.Cl. <sup>7</sup> H04B 1/69-1/713 H04B 7/005 H04B 7/24-7/26 H04Q 7/00- 7/38		
Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched		
Jitsuyo Shinan Koho 1926-1996 Toroku Jitsuyo Shinan Koho 1994-2000 Kokai Jitsuyo Shinan Koho 1971-2000 Jitsuyo Shinan Toroku Koho 1996-2000		
Electronic data base consulted during the international search (name of data base and, where practicable, search terms used)		
<b>C. DOCUMENTS CONSIDERED TO BE RELEVANT</b>		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	EP, 0853393, A1 (NTT MOBILE COMMUNICATIONS NETWORK INC.), 15 July, 1998 (15.07.98), ALL DOCUMENT & WO, 97/50197	1-14
A	EP, 0917303, A1 (MATUSHITA ELECTRIC INDUSTRIAL CO., LTD.), 19 May, 1999 (19.05.99), ALL DOCUMENT & JP, 11-145856, A	1-14
A	EP, 0942541, A2 (MATUSHITA ELECTRIC INDUSTRIAL CO., LTD.), 15 September, 1999 (15.09.99), ALL DOCUMENT & JP, 11-261481, A	1-14
A	EP, 0948221, A2 (MATUSHITA ELECTRIC INDUSTRIAL CO., LTD.), 06 October, 1999 (06.10.99), ALL DOCUMENT & JP, 11-261544, A	1-14
A	JP, 11-266199, A (Matsushita Electric Ind. Co., Ltd.), 28 September, 1999 (28.09.99), (Full text) (Family: none)	1-14
A	JP, 11-122212, A (Oki Electric Industry Co., Ltd.), 30 April, 1999 (30.04.99),	4-9
<input checked="" type="checkbox"/> Further documents are listed in the continuation of Box C. <input type="checkbox"/> See patent family annex.		
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Date of the actual completion of the international search 19 December, 2000 (19.12.00)		Date of mailing of the international search report 16 January, 2001 (16.01.01)
Name and mailing address of the ISA/ Japanese Patent Office		Authorized officer
Facsimile No.		Telephone No.

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## INTERNATIONAL SEARCH REPORT

International application No.

PCT/JP00/06973

C (Continuation). DOCUMENTS CONSIDERED TO BE RELEVANT		
Category*	Citation of document, with indication, where appropriate, of the relevant passages	Relevant to claim No.
A	(Full text) (Family: none) JP, 11-196456, A (Oki Electric Industry Co., Ltd.), 21 July, 1999 (21.07.99), (Full text) (Family: none)	4-9

Form PCT/ISA/210 (continuation of second sheet) (July 1992)